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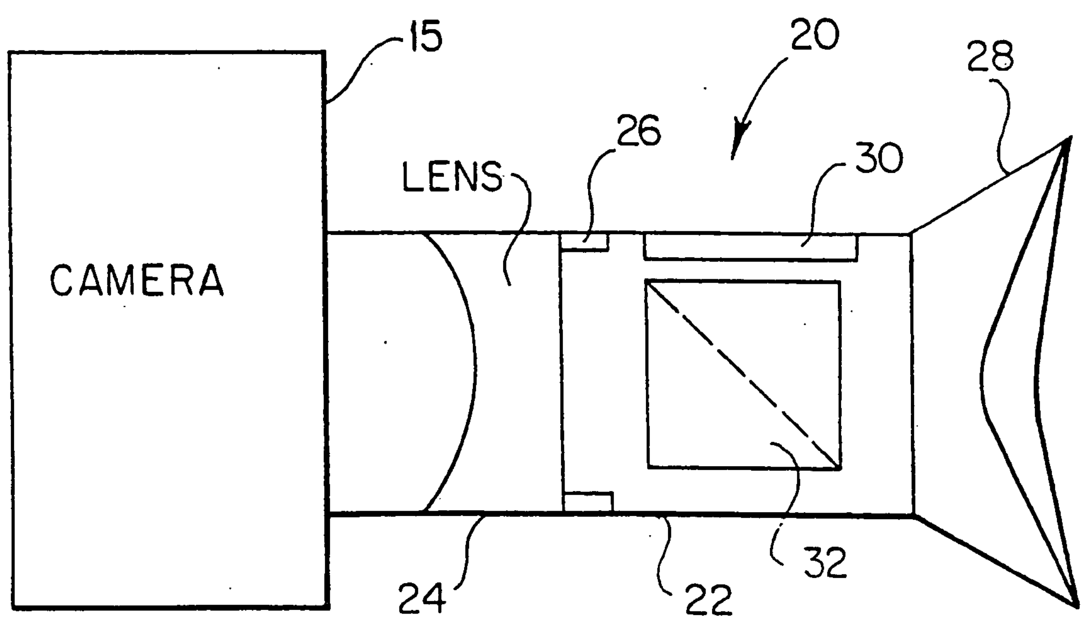

(57) Abstract

A system for observing and detecting evidence (A), including fingerprints. The system includes an attachment (20) for video camera (15) that allows a "live" fingerprint to be observed and recorded so that it may be compared with latent fingerprints that may be detected and recorded with the same system when the attachment (20) has been removed. The attachment (20) includes a beamsplitter (32) for directing light to a finger cradled for viewing by a video camera (15). When the attachment (20) is removed, the video camera (15) uses a pair of matched filters (40, 42), a source of noncoherent light (10), a light intensifier (44) to detect the wavelength-shifted luminescence from fluorescent substances. The system may be hand held and portable.

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FINGERPRINT OBSERVATION AND RECORDING SYSTEM

BACKGROUND OF THE INVENTION

The present invention relates to systems for observing and detecting evidence. More particularly, it relates to portable systems that can both view "live" fingerprints and detect latent fingerprints at the scene of a crime.

The observation and detection of objects or features not normally visible to the human eye has long been recognized as a significant problem, especially in the field of law enforcement where observation and detection of evidence are of critical importance.

Fingerprints are typically observed "live" (i.e., on the finger) by viewing an imprint of an inked finger or by photographic means, such as disclosed in U.S. Patent No. 4,652,116. Such observations take place at a central station where the requisite equipment is available. It has long been an object of investigative agencies to have a portable device that can be used to record the image of a "live" fingerprint of a suspect and to detect and record the image of latent fingerprints at the scene of a crime so that the recorded images may be compared on the scene.

Systems for detecting fingerprints frequently use lasers because of the laser's high detection rate. The laser excites fluorescent substances carried by the fingerprint making the fingerprint visible. The laser may excite fluorescent substances in the fingerprint residue itself, or fluorescent substances deposited on and carried by the fingerprint such as powders, dyes or chemical reagents. Such devices may also be used to detect fluorescent evidence other than fingerprints such as certain fibers and sweat. See, for example, U.S. Patent Nos. 4,708,882 and 4,794,260 to Asano, et al.

Lasers, however, present new problems to the crime scene investigator. Their portability is extremely limited and they may be unwieldy in confined spaces because they require a large power supply which must be transported to the scene. They may also be unsafe to operate because the laser beam itself is hazardous and caution must be taken so that it does not reach the human eye either directly or by luminescence.

Latent fingerprints (i.e., fingerprints left on objects) may, of course, be detected without lasers by using dusting powders,

fuming and chemical reagents. Viewing may be enhanced by the use of ultraviolet light. See, for example, U.S. Patent No. 4,504,408 to Morton. These techniques, however, generally have lower success rates than laser detection techniques. Old prints and prints on porous materials are particularly difficult to detect. Other non-laser systems have achieved higher success rates (see, for example, U.S. Patent No. 5,034,615 to Rios, et al.), but do not have the versatility to view "live" fingerprints.

It is particularly desirable to be able both to record the images of "live" fingerprints from suspects or victims at the crime scene and of latent fingerprints, and to make hard-copy prints of the images. The equipment necessary to perform these functions, however, is not easily transported to the scene of the crime, especially if used in conjunction with the bulky laser detectors. In some situations, it may be advantageous to transmit the images from the location of the evidence to remotely located recording and/or printing equipment. While systems for remotely displaying images are known for certain military applications, they have not been applied to "live" fingerprint observation and evidence detection (see, for example, U.S. Patent No. 4,786,966 to Hanson, et al.).

It is accordingly an object of the present invention to provide a novel system for both observing "live" fingerprints and for detecting latent fingerprints, that obviates the problems of the prior art and is portable and safe to use.

It is another object of the present invention to provide a novel attachment for a camera that may be used to observe and record "live" fingerprints.

It is still a further object of the present invention to provide an apparatus which can be used by police and similar departments for plural purposes in the investigation of crime scenes and criminal activity.

It is also an object of the present invention to provide a fingerprint observation and detection system that is portable, yet records images of fingerprints and produces hard-copy prints of the images.

These and many other objects and advantages will be readily apparent to one skilled in the art to which the invention

pertains from a perusal of the claims, the appended drawings, and the following detailed description of preferred embodiments.

THE DRAWINGS

Figure 1 is a schematic representation of an embodiment of the observation and detection system of the present invention.

Figure 2 is a partial pictorial and partial schematic representation of an embodiment of the "live" fingerprint observation attachment of the present invention.

Figure 3 is a partial pictorial and partial schematic representation of a side view of an embodiment of the present invention.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

With reference new to the figures where like elements have been given like numerical designations to enhance an understanding of the present invention, and particularly with reference to Figure 1, the detection device of the present invention may include a source of noncoherent light 10 (lasers provide coherent light) for illuminating the evidence A, a camera 15 for receiving and intensifying light reflected from the evidence A, and a removable attachment 20 that may be used to observe "live" fingerprints.

With reference now to Figure 2, the attachment 20 for a camera 15 that may be used to observe "live" fingerprints may be more clearly seen. The body 22 of the attachment may be a hollow tube that may be removably attached to a lens 24 of a camera 15, such as a video, television or photographic camera, with a threaded coupler 26 at one end of the tube 22. At the other end of the tube 22 is a bottomless cup 28 for cradling a finger whose fingerprint is to be observed by the camera. To allow light to reach the interior of the tube so that the finger in the cup 28 is bathed in sufficient light to be detected by the camera, a glass window 30 may be positioned in the wall of the tube 22. The window 30 is preferably one that can diffuse light as it enters the tube 22 so that the finger is bathed uniformly. To this end, the window 30 may be a diffuse opal glass. The window 30 may extend part or completely around the circumference of the tube 22.

A beamsplitter 32 is placed inside the tube 22 to direct the light onto the finger. Light from the window 30 is deflected by the beamsplitter 32 toward the cup 28 where the image of the cupped finger is reflected back through the beamsplitter 32 onto the lens 24. The beamsplitter may be a 50/50 cube beamsplitter or other known devices able to deflect light from the window 30 toward the cup 28 and to allow the reflected light to reach the lens 24.

In operation, the attachment 20 is removably affixed to a camera using coupler 26. The finger whose fingerprint is to be observed "live" is placed in the cup 28. External light, as from the light source 10, may be directed through the window 30 where it is diffused onto the finger in the cup 28. When the finger has sufficient illumination, the camera 15 may be operated to record the image of the fingerprint. The attachment 20 may then be removed so that the fingerprint detector may be used to detect and record latent fingerprints, as will be discussed below. Subsequently, the recorded images may be compared on the scene using techniques known in the art to determine whether the suspect whose "live" fingerprint was recorded should be detained.

The latent fingerprint detector exploits the wavelength shift of light reflected from a fluorescent substance. As is well known, the wavelength of light is increased upon luminescence from a fluorescent substance (the light undergoes a wavelength shift in accordance with Stokes' Law). Thus, if a fluorescent substance is illuminated with light of a particular wavelength, the luminescence may be detected at a longer wavelength.

With reference new to Figure 3, light from light source 10 is filtered by filter 40 to illuminate a fluorescent substance with light having a predetermined band of wavelengths, for example, 555 to 565 nanometers. When a fluorescent substance is so illuminated, the luminescence from the substance may be detected in a band of wavelengths about 10% longer (10% is the wavelength shift at this incident wavelength); 610 to 622 nanometers in this example. By providing a second filter 42 that filters out light outside the wavelength band of the reflected light, only the desired luminescence are detected. The filters 40 and 42 thereby cooperate to first illuminate and then enable detection of fluorescent substances.

To enhance detection of the luminescence, a light intensifier 44 may be provided to increase the luminance of the luminescence. The luminescences have been found to be particularly dim, even when the source is bright. The intensifier increases the luminance of the luminescence so that relatively high detection rates may be achieved.

To further enhance detection, the present invention may be operated when the fluorescent substances are shielded from all other light sources. By so doing, the intensifier does not receive light at the wavelength band of the second filter that may be reflected from objects other than those activated by the filtered light source.

As is known, a fluorescent substance may be applied to evidence (e.g., fingerprint) so that its image may be more clearly seen. While any known application system is acceptable, dusting is preferred to enhance the portability of the present method and to reduce damage to the material bearing the fingerprints.

When a fine fluorescent dust is applied to a surface bearing a fresh fingerprint, the dust adheres more readily to the oil which forms the print than to the surrounding surface. The oil typically has been left in a pattern resembling the valleys between fingerprint ridges. Thus, the dust concentrates in a pattern resembling the fingerprint and the fingerprint fluoresces. If the fingerprint is not fresh or is dry, there is little or no oil on which the dust can adhere. However, in drying the oil typically turns into an amino acid which etches the surface at the submicron level. While such etching is often invisible to the naked eye, even if aided by conventional black fingerprint dusting powders, the fine dust of the fluorescing powder will be relatively more trapped by the etching traces and thereby reveal the ridge pattern of the of the fingerprint which originally was left on the surface.

With further reference now to Figure 3, the light source 10 may be any source of noncoherent light, such as an incandescent lamp containing halogen or krypton with a tungsten filament. It is desirable that the source have a luminous intensity of about 100 lux. While a practical minimum intensity depends on the strength of the intensifier, it has been found that below about

25 lux the efficiency of the intensifier is reduced by the introduction of noise.

The first filter 40 may be any known fine-cut filter that is capable of creating a wavelength band (the one-half bandpass) of between 5 and 15 nanometers, with about 10 nanometers preferred. The center wavelength is desirably in the range of 500 to 600 nanometers, with about 560 $\pm$ 4.8 nanometers preferred. In the 500 - 600 nanometer band, the preferred wavelength has been found to produce the highest overall detection rate of fluorescing evidence (e.g., fingerprints, body fluids, hair) on a wide variety of surfaces, such as paper, plastic, metal, wood and glass. The first filters 40 may be replaceable so that the present invention may be used to enhance detection of different dyes and with composition studies.

The second filter 42 may be identical to the first filter 40, except that the wavelength band should be correspondingly 10% higher.

The wavelength bands of filters 40 and 42 should not be so large that they overlap. If the bands were to overlap, reflected light that has not been wavelength shifted by the fluorescent material may be received, degrading operation of the device. A separation of about 10 nanometers is acceptable, with about 20 nanometers preferred. Increased separation improves the signal-to-noise ratio throughout the system, thus improving image quality as measured by both spatial resolution and contrast.

Where evidence detection is by ultraviolet light, the center wavelength of the first filter is desirably in the range of a center 300 to 400 nanometers, with about 334 nanometers preferred. In this event, the center wavelength of the second filter may be about 20% higher; that is about 405 nanometers when the first filter operates at 334 nanometers. The wavelength shift caused by the fluorescent material is greater at shorter wavelengths.

Where the present invention is to operate in the infrared spectrum, the first filter may be an infrared filter with a long wave cutoff at about 1100 nanometers. In this event, the second filter may admit all wavelengths from about 400 to 1100 nanometers.

A lens 46 may be provided with the filter 42 to enhance the light-gathering power of the device. While a particular minimum power is not required, a power of f/2.0 or better (e.g., f/1.4) is preferred. The lens 46 may be fixed (e.g., 25mm) or may have a variable focal length and iris opening and may be a zoom lens (e.g. 28 to 70 mm). Alternatively, or in addition, the filter may be in form of or integral with the lens.

For example, and with reference to Figure 3, a 25 millimeter f/1.4 television lens 46 may be removably attached to the camera 15. The second filter 42 may be integrated with the lens or removably attached thereto so that attachment 20 may be used. The intensifier 44 may be a 25 millimeter micro-channel plate intensifier. An image generator 48 may include a charged couple device (CCD) image sensor 50, and an appropriate optical coupling system 52 for coupling the intensifier 44 to the image sensor 50. The image generator 48 may operate in the NTSC RS 170 video format. This embodiment may provide a two inch diameter viewing area eight inches from the lens.

The relatively broad wavelength band of the filters 40 and 42 (10 nanometers, as compared with 0.1 nanometers for lasers) increases the efficiency of the filters. For example, the first filter 40 may have an efficiency of 50% and the second filter 42, 90%. These relatively high efficiencies allow the use of a lower power intensifier 44. This is significant in the present invention because a low power intensifier has reduced energy requirements and increased portability.

The light intensifier 44 may be any known means for increasing the luminance of light it receives. While an intensifier capable of increasing luminance several thousand times is acceptable, an increase of about twenty thousand is preferred. Intensifier 44 may be, for example, a television system capable of detecting and intensifying low levels of light. A second generation micro-channel plate is preferred because it provides low "blooming" (highly luminescent luminescence do not wash out weaker luminescence), high contrast and resolution, and is easily adapted for TV and photographic cameras.

The present invention may be completely portable. Batteries 54, such as common 1.5 volt dry cell batteries, may be provided to power the light source 10 and intensifier 44. Appropriate

circuitry may be provided so that the device may operate from household current as well. The images produced by the intensifier may be viewed through an eyepiece 56 that may be focused. A remote monitor 58 may also be provided.

With further reference to Figure 1, a system of the present invention may include a transmitter 60 for transmitting an image of the "live" or latent fingerprints to a receiver 62 that may be remote from the evidence. Display 64 for the image may be adapted to operate with the receiver 62. An appropriate recorder 66 and/or printer 68 may also be provided.

In operation, the camera 15 and transmitter 60 may be hand carried to the scene of the evidence where the camera 15 may be used with the attachment 20 to observe and/or record "live" fingerprints, to detect latent fingerprints and to generate an image in the form of a signal that may be fed monitor 58 so that the image may be viewed at the scene to allow the operator of camera 15 to more easily detect and view the "live" and/or latent fingerprints. The images may also be fed to transmitter 60 for transmission to a support facility with recorder 66 and printer 68 such as a car or truck located within range of the transmitter. Signals generated by camera 15 may thereby be printed and saved without transporting the equipment for such tasks to the evidence.

The source of noncoherent light 10 may be movably positioned so that light at an appropriate incident angle and distance from the evidence may be provided. One or more sources of light may be used, with two sources being preferred. As may be seen in Figure 3, the source of light may be attached to the side of a case 70 and operated by the trigger 72 through appropriate circuitry. Each source of light 74 may include a source of broadband light 76 mounted at one distal end of a flexible neck 78.

While preferred embodiments of the present invention have been described, it is understood that the embodiments described are illustrative only and that the scope of the invention is to be defined solely by the appended claims when accorded a full range of equivalence, many variations and modifications naturally occurring to those skilled in the art from the perusal thereof.

We Claim:

1. A system for viewing a fingerprint with a camera comprising:

a tubular body adapted to be removably attached at a first end to a camera;

window means in a side wall of said body for diffusing light interior to said body;

beamsplitter means interior to said body for diverting diffused light from said window means toward a second end of said body: and

a concave bottomless cup at said second end adapted to cradle a finger so that its fingerprint is bathed in light from said beamsplitter means and viewed by a camera attached at said first end.

2. The system of Claim 1 wherein said beamsplitter means comprises a 50/50 cube beamsplitter.

3. The system as defined in Claim 1 wherein said tubular body is adapted to be removably attached to a lens of a video camera.

4. The system as defined in Claim 3 wherein said video camera is adapted to detect fluorescent evidence, including fingerprints, and said video camera comprises:

(a) light means for illuminating the evidence with light of a first predetermined wavelength band, said light means comprising,

(i) a source of broadband noncoherent light,

(ii) filter means for filtering light from said source of light so that light of said first wavelength band is emitted by said light means,

(iii) means for movably positioning said source of light so that the evidence may be illuminated thereby; and

(b) detection means for intensifying light of a second predetermined wavelength band luminescing from the evidence and for generating an image thereof so that the evidence may be detected.

5. The system as defined in Claim 4 wherein said filter means comprises plural interchangeable filters.

6. The system as defined in Claim 4 wherein said video camera comprises a zoom lens.

7. The system as defined in Claim 4 wherein said video camera comprises a charged couple device image sensor, and an optical coupling system.

8. The system as defined in Claim 7 wherein said video camera further comprises means for operating in a NTSC RS 170 video format.

9. The system as defined in Claim 4 further comprising means for recording the signal received at said camera.

10. The system as defined in Claim 4 further comprising a local display carried by and connected to said camera so that evidence may be detected locally.

11. The system as defined in Claim 4 further comprising a battery for operating said camera.

12. The system as defined in Claim 4 wherein said first wavelength band is 300 to 400 nanometers.

13. The system as defined in Claim 4 wherein said first wavelength band is 500 to 600 nanometers.

14. The system as defined in Claim 4 wherein said first wavelength band is infrared with an 1100 nanometer wavelength cutoff.

15. The system as defined in Claim 14 wherein said second wavelength band is 400 to 1100 nanometers.

AMENDED CLAIMS

[received by the International Bureau on 23 November 1992 (23.11.92); new claim 16 added; other claims unchanged (1 page)]

7. The system as defined in Claim 4 wherein said video camera comprises a charged couple device image sensor, and an optical coupling system.

8. The system as defined in Claim 7 wherein said video camera further comprises means for operating in a NTSC RS 170 video format.

9. The system as defined in Claim 4 further comprising means for recording the signal received at said camera.

10. The system as defined in Claim 4 further comprising a local display carried by and connected to said camera so that evidence may be detected locally.

11. The system as defined in Claim 4 further comprising a battery for operating said camera.

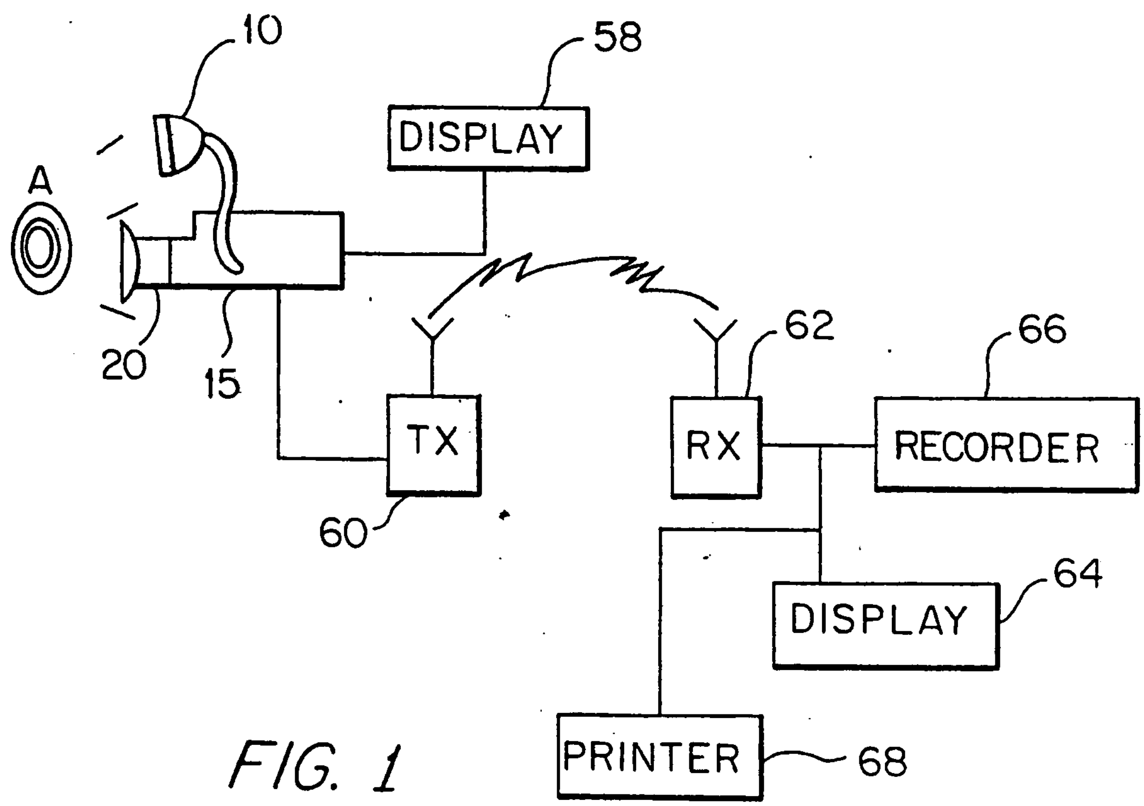
12. The system as defined in Claim 4 wherein said first wavelength band is 300 to 400 nanometers.

13. The system as defined in Claim 4 wherein said first wavelength band is 500 to 600 nanometers.

14. The system as defined in Claim 4 wherein said first wavelength band is infrared with an 1100 nanometer wavelength cutoff.

15. The system as defined in Claim 14 wherein said second wavelength band is 400 to 1100 nanometers.

16. The system as defined in Claim 1 wherein said bottomless cup is conformal in shape to the end portion of a human finger.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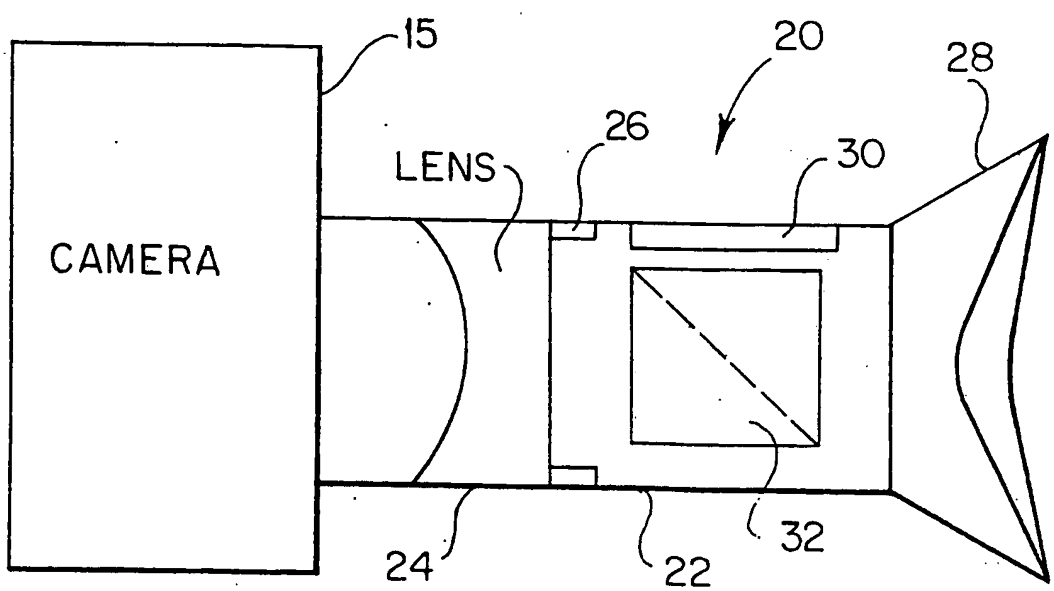
DISPLAY
A
20
15
62
66
TX
RX
RECORDER
60
64
DISPLAY
PRINTER
68

FIG. 1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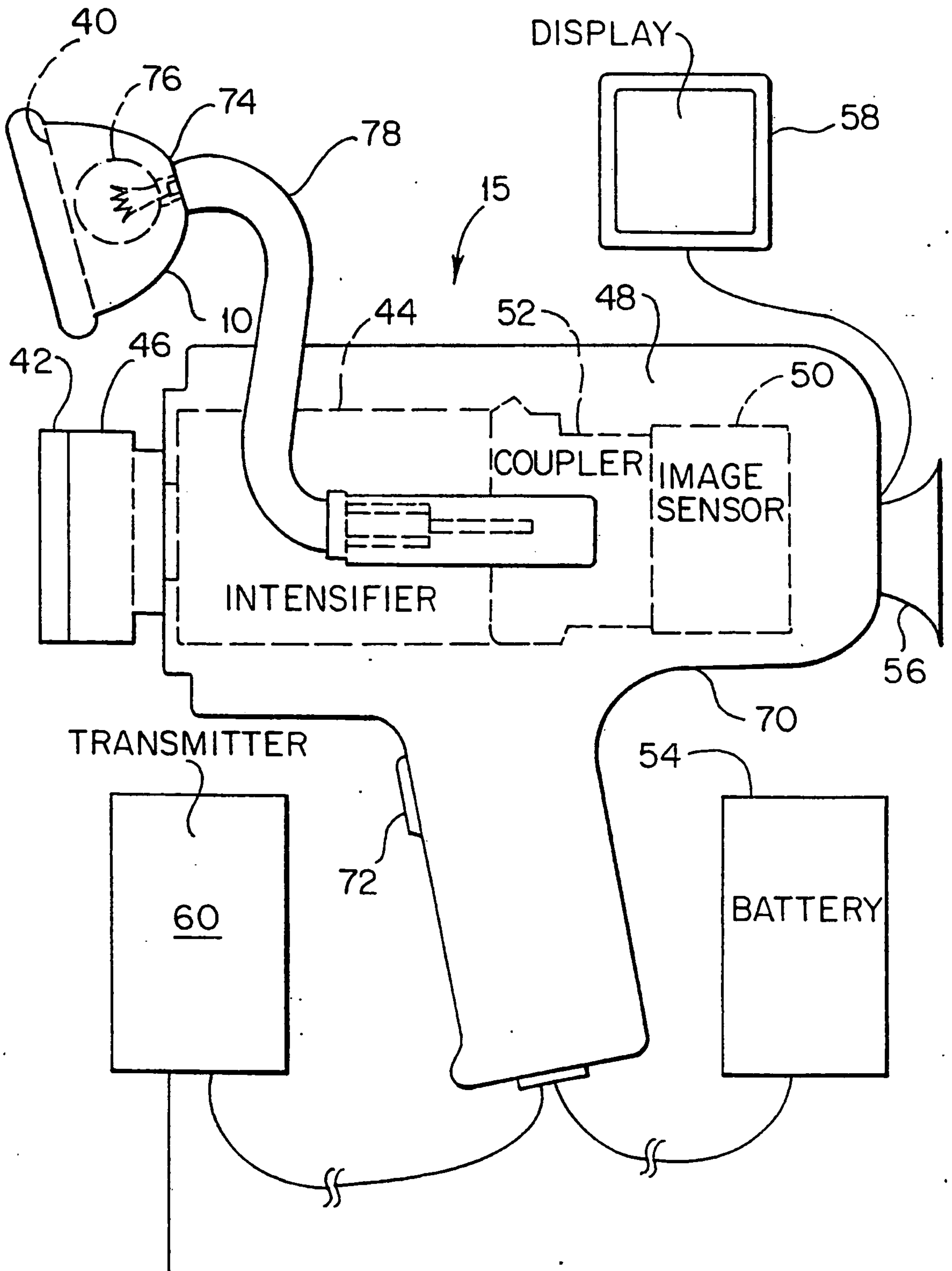
26
30
LENS
CAMERA
32
24
22

FIG. 2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76
74
78
DISPLAY
58
15
10
44
52
48
42
46
50
COUPLER
IMAGE SENSOR
INTENSIFIER
56
70
TRANSMITTER
54
72
60
BATTERY

FIG. 3

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US92/02459

A. CLASSIFICATION OF SUBJECT MATTER

IPC(5) :G06K 9/22; G01J 1/58
US CL :250/458.1, 461.1; 356/71; 283/69, 70, 78; 354/62; 382/4
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

U.S. : 250/458.1, 461.1; 356/71; 283/69, 70, 78; 354/62; 382/4

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

AUTOMATED PATENT SYSTEM (APS)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US, A, 4,109,273 (HILL) 22 August 1978, see columns 3, lines 19-27 and 66-68; column 4, lines 1-26; and column 5, lines 26-44.	1-15
Y	US, A, 5,034,615 (RIOS ET AL.) 23 July 1991, see figures 1 and 3; and column 3, line 62 through column 6, line 16.	4-15
Y	US, A, 5,099,131 (BROWNRIGG ET AL.) 24 March 1992, see figure 3 and column 4, lines 1-40.	1-3
A	US, A, 4,236,082 (BUTLER) 25 November 1980, see entire document.	
A	US, A, 4,787,742 (SCHILLER ET AL.) 29 November 1988, see entire document.	
A	US, A, 4,794,260 (ASANO ET AL.) 27 December 1988, see entire document.	

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

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Date of the actual completion of the international search	Date of mailing of the international search report
14 SEPTEMBER 1992	20 OCT 1992

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